3E1117

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B. Tech. III - Sem. (Main / Back) Exam., Dec. 2019

PCC Automobile Engineering

3AE4-05 Engineering Thermodynamics

AE, ME

Time: 3 Hours **Maximum Marks: 120**

Instructions to Candidates:

Attempt all ten questions from Part A, five questions out of seven questions from Part B and four questions out of five from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. Steam Tables and Mollier Chart 2. NIL

PART – A

(Answer should be given up to 25 words only) **[10×2=20]**

All questions are compulsory

Q.1 Differentiate between closed and open systems.

Q.2 What is the significance of First law of thermodynamics?

Q.3 Explain the difference between refrigerator and heat-pump.

Q.4 Why second law is called the law of degradation of energy?

Q.5 What do you understand by Entropy principle?

Q.6 What are saturation states? What is the critical state?

Q.7 What is Joule Thomson coefficient? Why is it zero for an ideal gas?

Q.8 State Gibbs Dalton law.

Q.9 Mention the demerits of Ericsson cycle?

Q.10 What are the basic components of steam power plant? What do you mean by average temperature of heat addition?

PART – B

(Analytical/Problem solving questions) [5×8=40]

Attempt any five questions

Q.1 A house requires 2×10^5 kJ/hr for heating in winter. Heat pump is used to absorb heat from cold air outside in winter and send heat to the house. Work required to operate the heat pump is 3×10^4 kJ/hr. Determine-

(i) Heat absorbed from outside

(ii) Coefficient of performances

Q.2 Prove that for a polytropic process, the change of entropy is given by

$$s_2 - s_1 = \frac{\gamma - n}{\gamma - 1} R. \ln\left(\frac{v_2}{v_1}\right)$$

Where, the symbols have their usual meanings.

Q.3 Derive the general expression for the maximum work of an open system which exchanges heat only with the surroundings.

Q.4 With the help of Maxwell's relations prove that enthalpy of an ideal gas is function of temperature only.

Q.5 A rigid vessel of volume 1 m^3 contains steam at 19 bar and 300°C. The vessel is cooled until the steam is just dry and saturated. Calculate the mass of steam in the vessel, the final pressure of the steam and the heat removed during the process.

Q.6 Draw P-v and T-s diagram of the Brayton cycle and derive an expression for its thermal efficiency. Also, derive an expression to determine the optimum pressure ratio for the maximum specific output of Brayton cycle.

Q.7 Derive an expression for the air standard efficiency and mean effective pressure of ideal Diesel cycle. Show the cycle on P-v and T-s diagram, describing the processes, briefly.

PART – C

(Descriptive/Analytical/Problem Solving/Design Questions) **[4×15=60]**

Attempt any four questions

Q.1 A quantity of air initially occupies a volume of 0.028 m^3 at a pressure of 7 bar, and temperature of 260°C. The gas is expanded at constant pressure to 0.084 m^3. A polytropic process with n=1.50 is then carried out, followed by isothermal process which completes the cycle. All processes are reversible. Sketch the cycle in P-v and T-s planes and determine for each process-

(i) The heat transfer

(ii) The work done or required

(iii) The change of entropy.

Q.2 A steam generated at a pressure of 50 bar, 400°C is supplied to a throttle valve where its pressure drops to 40 bar. It then enters a turbine and expanded isentropically up to a pressure of 4 bar. On leaving the turbine, the steam is taken at a velocity of 60 m/s to a nozzle where it expands until the steam at the exit of nozzle is at pressure of 1.5 bar and dryness fraction 0.9. The changes in K.E. and the P.E. in the throttle valve and turbine are neglected. Determine the following:

(i) Power output by the turbine assuming steam flow rate of 2 kg/s.

(ii) The velocity of steam at the exit of nozzle assuming no heat loss.

Q.3 0.5 kg of air as an ideal gas executes a Carnot cycle having a thermal efficiency of 50%. The heat transferred to the air during the isothermal expansion is 40 kJ. At the beginning of the isothermal expansion, the pressure is 7 bar and volume is 0.12 m^3. Determine the following:

(i) The maximum and minimum temperature of the cycle

(ii) The volume at the end of isothermal expansion

(iii) The work and heat transfer for each kg of four processes

(iv) Sketch the cycle on P-v diagram.